## Grid2003.

The Grid2003 project has deployed and operated a common Grid environment used by sixVirtual Organizations, and consisting of more than 26 sites and 2500 processors.

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## U.S. ATLAS & U.S. CMS,

## Grid Physics Network

## Particle Physics Data Grid

## International Virtual Data Grid Laboratory

### Grid2003 – an Application Grid Demonstrator

The Grid2003 project has built a first shared Grid environment, Grid3, across U.S. Laboratories and Universities to run applications from the participating experiments and comptuer science groups. Grid2003 is a collaboration between U.S. ATLAS, U.S. CMS, and the U.S. Physics Grid projects GriPhyN, iVDGL and PPDG, this way also including Condor and Globus. The goal of Grid2003 was to demonstrate specified metrics (demonstrated at the SC2003 conference in Phoenix in November), and to continue to operate the grid to the benefit of the collaborating organizations. The Grid3 environment continues to be used for the U.S.CMS DC04 and for U.S. ATLAS DC2 data challenges.

Grid2003 sustains the running of more than 500 simultaneous jobs across 26 sites, together providing over 2500 processors. The Grid has remained operational in its initial configuration since SC2003 Grid2003 was organized as a project team of more than thirty people contributing part-time and representing all aspects of the system, from applications, system and middleware grid services, processing and storage site administrations, and the stakeholders.
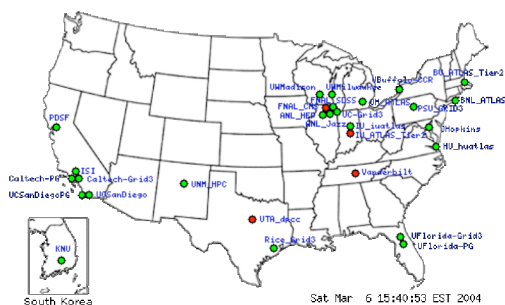


**Grid3 Site Map**

### Applications Running on Grid2003

Grid2003 Applications running to date are:
  ATLAS proton-proton collision simulation;
  CMS proton-proton collision simulation;
  LIGO gravitational wave search;
  SDSS galaxy cluster detection;
  ATLAS interactive analysis;
  BTeV proton-antiproton collision simulation;
  SnB biomolecular analysis;
  GADU/Gnare genone analysis; and
  Computer Science experiments testing resource planning and data movement.

### Grid2003 metrics:

Grid2003 met the following metrics:

| Metric | Target | Achieved |
|---|---|---|
| Number of CPUs | 400 | 2762 (28 sites) |
| Number of users | > 10 | 102 (16) |
| Number of applications | > 4 | 10 (+CS) |
| Number of sites running concurrent apps | > 10 | 17 |
| Peak number of concurrent jobs | 1000 | 1100 |
| Data transfer per day | > 2-3 TB | 4.4 TB max |

### Interoperability Demonstrations

Specific interoperability tests with the LHC Computing Grid Project  have been performed, showing scheduling of ATLAS jobs and CMS data movement across Grid2003 and the LCG site at CERN.

### Future Plans

The Grid remains operational following a review of the lessons learned from the project. Future plans include deployming Storage Elements, and establishing separate infrastrucutres for the development and operational grid.

**Grid2003 Services and Design Principles:** Grid2003 offers only a simple sub-set of the complete set of services required to support physics data analysis on the Grid. It includes a sufficient set of services to support running production-type applications across resources contributed from several "virtual organizations" (VO), making use of a loosely coupled set of computing centers at the Universities and Laboratory Facilities.

**Operations:** Grid2003 is supported by the distributed set of site administrators, middleware providers and application coordinators. The iVDGL Grid Operations Center (iGOC), based at Indiana University contributes Operations Services participating in operations support for Grid2003 and support for central servers such as the GIIS, MonaLisa and VOMS databases.

**PKI Certificate Services.** ESNET provides the DOEGrids Certificate Authority for the allocation of PKI certificates used for authentication within Grid3.

**Common Middleware Services**: The Grid2003 services build upon a common software environment, consisting of the Virtual Data Toolkit (VDT), components developed by the European Data Grid project (EDG).. Additional components for configuration, monitoring, information schema, information providers, authentication management are available through the Grid2003 software cache and Savannah portal.

**Processing sites (Compute Elements)** consist of a head node with a gatekeeper service and a set of worker nodes All sites are pre-existing. Supported batch systems are LSF, PBS (including Maui extensions), FBSNG, Condor. The Grid2003 environment requires no special software installations on the worker nodes. Applications are dynamically installed and do not require special privileges or actions by site system administrators.

**Virtual Organization Management** services are provided using the EDG/DataTAG Virtual Organization Management Software (VOMS) for central registration of user information. Job execution, policy and monitoring is based on a simple VO mapping.

**Job Submission and Management** services are provided through the use of Condor-G using the GRAM protocol. Condor-G manages the submission of the jobs, the Globus Gatekeeper submits the jobs to the local Compute Element batch queue, the Condor GridMonitor manages the load on the local head node, and all components cooperate to manage retries, report errors and monitor the job submissions. Several application use DAGMan and Chimera to mange the job workflow at different levels.

**Data Movement** services are provided through the use of GridFTP. Once initial firewall and open port issues were resolved, data movement has been stable across the Grid.

**Information Services** are provided using GLOBUS MDS. Sites publish information about the directories into which applications should be installed, temporary data should be written, and input and output data should be staged. Information from the whole grid is available through a single top-level GIIS and associated web pages. During the project we updated the MDS version, which required an update by all sites. Pacman supports this in an easy fashion, and the update was accomplished without perturbing running jobs. One lesson learned was that all such upgrades resulted in taking a lot of effort for configuration and tuning, highlighting need for more planning, automation and testing for future configuration management and tuning.

**Monitoring Services** on Grid2003 are provided by several monitoring systems, with each proving its use in operating and sustaining the performance of the system. The MonALISA system was used as the core monitoring system. It was extended for Grid2003 to collect and present information based on each VO. This allowed accounting for usage of resources by each VO on each Grid2003 site. Through a collaboration with the University of Chicago Grid Telemetry project, a system for measuring and analyzing the Grid2003 metrics was developed, making use of the archived MonALISA information . A sample plot for U.S. CMS is shown below.